UNITED STATES PATENT APPLICATION

OF

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FOR

A BROWSING BASED CHINESE INPUT METHOD

(revised version)

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January 12, 2006

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Field of the invention

The present invention relates to inputting Chinese text data into a computer.

Related US patent documents

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6,008,799 Dec. 1999, V. Kleeck, Method and System for Entering Data Using Improved On-Screen Keyboard.

6,157,371 Dec. 2000, J. P. A. Smeets, Data Processing System Provided with Soft Keyboard that Shifts between Direct and Indirect Character.

6,232,969 May 2001, G. S. Fawcett, Device for Composing or Editing a String of Characters.

6,271,835 Aug. 2001, H. Hoeksma, Touch –Screen Input Device.

6,359,572 Mar. 2002, P. O. Vale, Dynamic Keyboard.

6,562,078 May 2003, Yang et. al., Arrangement and Method for Inputting Non-Alphabetic Language.

6,809,725 B1 Oct. 26, 2004, J. Zhang, On Screen Chinese Keyboard.

Other References

TwinBridge user's guide 4.0, 1995 TwinBridge Software Corporation.

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Background

The soft keyboard has long been used as a supplementary tool for inputting

Chinese text data into a computer. The idea is to draw a keyboard on the screen so

that a user can use a pointing device such as a mouse or a touch pen to activate all

5   events to simulate the real keyboard operations. In implementations one mouse-click

or one pen-tap ordinarily corresponds to one keystroke on a real keyboard.

With a specific Chinese phonetic system, the spelling of each character is a string

of phonetic symbols ended with a tonal symbol. Entering spellings of the phrase

characters into a computer is a way to get the phrase candidate set in a Chinese

10   sentence composition. One commonly used strategy for a phrase specification is to

enter the full spelling of each character. The tonal symbols at the end of the full

spellings unambiguously separate the string of phonetic symbols into syllables.

Another phrase candidates specifying strategy called abbreviated method enters

only partial spellings of the characters. For longer phrases, the abbreviated method is

15   in general more efficient to specify the phrase candidate set than specifying full

spellings. Ambiguities may arise in separating the symbol string of a sequence of

partial spellings. A user needs to insert tonal symbols or marks between the partial

spellings in the process to resolve the ambiguities in syllable demarcation.

In a soft keyboard design the phonetic keys are often partitioned into groups and

20   the groups are placed into sections to make it easier to locate keys. The sections are

further arranged on the screen in a way to facilitate the moving of the pointing device

to perform click or tap operations.

SUMMARY OF THE INVENTION

The present invention is a methodology for a user to input Chinese text data into a computer by using a pointing device on a soft keyboard. Two protocols to be used by a user to communicate with a computer are disclosed. One of the protocols is to be used with the Zhu-Yin phonetic system while the other one is to be used with the Pin-Yin phonetic system. Both protocols allow a user to enter a sequence of partial spellings for phrase specification without inserting separation marks.

The software embodiment of this invention is a program that first displays a soft keyboard on a screen for the user to navigate with pointing device operations. The program then translates the sequence of device event signals entered by the user into a sequence of partial spellings according to the implemented protocol and displays phrase candidates that match the resulting sequence of partial spellings in a window for the user to select. The insertion of the separation marks is done automatically by the program.

With the Zhu-Yin phonetic system, the soft keyboard consists of a consonant section, a transition vowel section, a vowel section, a tone section, and several function keys. A user performs a sequence of Press-Touch-Release-Touch (PTRT) operations to select the consonant, transition vowel, vowel, and tone components of the Chinese characters of a phrase, with each PTRT-operation performed in one continuous move. The layout of the soft keyboard is designed to facilitate this continuous move of the pointing device in the process.

With the Pinyin phonetic system, the symbol string of every spelling is segmented into four substrings as an initial symbol, a next symbol substring, a remaining symbol substring, and a tonal symbol. These symbols and substrings are assigned onto keys

4

and to be shown in panels. An initial platform containing a section of the alphabet

keys, a section of the tone keys, and several function keys is shown at the beginning.

During the input phase panels containing the keys of the next substrings, the

remaining symbol strings that can follow already entered symbol strings in spellings

5   are shown subsequently on the screen to support PTRT-operations for entering

sequences of Pin-Yin partial spellings.

10   **BRIEF DESCRIPTION OF THE DRAWINGS**

In the Figures:

        Figure 1 illustrates the lexical structure tree of the symbol strings of

the Zhu-Yin phonetic system.

        Figure 2 illustrates the lexical structure tree of the symbol strings of

15   the Pin-Yin phonetic system.

        Figure 3 illustrates the flow chart of the program that supports the browsing-base

Chinese input method in accordance with an embodiment of the invention.

        Figure 4 illustrates the system components of the Zhu-Yin phonetic system and

the layout of the Zhu-Yin keyboard in accordance with an embodiment of the

20   invention.

        Figure 5 illustrates the Press-Touch-Release-Touch (PTRT) operation for " ㄐ ㄧ

ㄝ l" on the Zhu-Yin keyboard in accordance with an embodiment of the invention.

        Figure 6 illustrates the state transition diagram of the *automatic partial Zhu-Yin*

spelling separation protocol in accordance with an embodiment of the invention.

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Figure 7 illustrates the generation of the sequence of the Zhu-Yin full spellings

"~ ㄓ ㄨ ㄢ 1~ㄌ ㄧ 4" of "專利" in accordance with an embodiment of the invention.

Figure 8 illustrates the generation of the sequence of the partial Zhu-Yin

spellings "~ ㄓ ㄨ ~ ㄌ ㄧ" of "專利" in accordance with an embodiment of the

invention.

Figure 9 illustrates the layout of the initial Pin-Yin keyboard and the phrase

window for the Pin-Yin phonetic system in accordance with an embodiment of the

invention.

Figure 10 illustrates the next substring Pin-Yin panel of the initial symbol "D" in

accordance with an embodiment of the invention.

Figure 11 illustrates the next substring Pin-Yin panels of symbol "Z" in

accordance with an embodiment of the invention.

Figure 12 illustrates the Press-Touch-Release-Touch operation for "ZHUAN1"

on the Pin-Yin panels in accordance with an embodiment of the invention.

Figure 13 illustrates the state transition diagram of the *automatic partial Pin-Yin*

spelling separation protocol in accordance with an embodiment of the invention.

Figure 14 illustrates the generation of the sequence of the Pin-Yin full spellings

"~ZHUAN1 ~ LI4" of "專利" in accordance with an embodiment of the invention.

Figure 15 illustrates the generation of the sequence of the Pin-Yin partial spelling

"~ZHU ~ LI" of "專利" in accordance with an embodiment of the invention.

NOTATIONS AND CONVENTIONS

The following notations and conventions will be used in the descriptions of this invention.

1. Each Chinese word is associated with a monosyllable pronunciation. Mandarin pronunciation for Chinese words will be used in the examples.

2. The pronunciation of a Chinese word in Mandarin can be represented by a Zhu-Yin (BoPoMoFo) phonetic symbol string followed by a tonal symbol 0 to 4, where 0 represents the light tone, and 1 to 4 represent tone-1 to tone-4.

For example, "專" is pronounced as "ㄓㄨㄢ 1", and "利" is pronounced as "ㄌㄧ 4". The pronunciation of "專利" is represented as "ㄓㄨㄢ 1 ~ ㄌㄧ 4", where "~" is the mark used to separate syllables.

The Zhu-Yin phonetic symbols will be classified into a consonant set (C-set), a transition vowel set (H-set), and a vowel set (V-set). The following are the lists of the C, H, and V sets.

C-set : { ㄅ ㄆ ㄇ ㄈ ㄉ ㄊ ㄋ ㄌ ㄍ ㄎ ㄏ ㄐ ㄑ ㄒ ㄓ ㄔ ㄕ ㄖ ㄗ ㄘ ㄙ blank}.

H-set : { ㄧ ㄨ ㄩ blank}.

V-set : { ㄚ ㄛ ㄜ ㄝ ㄞ ㄟ ㄠ ㄡ ㄢ ㄣ ㄤ ㄥ ㄦ blank}.

A blank symbol has been added to each of the C, H, and V sets to specify missing components in spelings.

Tonal symbols {0 1 2 3 4} will be referred as the T-set. The T-set can also be represented as { ˙ - ˊ ˇ ˋ }.

7

A standard Chinese word pronunciation can be represented by a string of

four symbols taken from each of the C, H, V, and T sets. For example, "專" is

pronounced as "ㄓㄨㄢ 1" with "ㄓ", "ㄨ", "ㄢ", and "1" with each belonging

to the C, H, V, and T sets. In some cases one or two phonetic symbol

5   components may be missing. For example, "利" is pronounced as "ㄌ一 4"

with the vowel component missing.

There are about 1400 valid word pronunciations for Mandarin Chinese.

Their Zhu-Yin representations can be grouped in the order of C, H, V, and T

sequence and organized as a lexical structure tree, as shown in Figure 1.

10   Figure 1 also shows the Chinese words associated with their pronunciation.

A Chinese word may have different pronunciations. Therefore, the phonetic

tree becomes a lattice diagram when the terminal nodes of Chinese words are

included.

3. The pronunciation of a Chinese word in Mandarin can also be represented by a

15   Pin-Yin phonetic symbol string consisting of a string of phonetic alphabet

symbols of A to Z followed by a tonal symbol 0 to 4.

For example, "專" is pronounced as "ZHUAN1", and "利" is pronounced

as "LI4". The pronunciation of "專利" is represented as "ZHUAN1 ~ LI4".

There is a 1-1 mapping between the set of valid Zhu-Yin phonetic symbol

20   strings and the set of valid Pin-Yin phonetic symbol strings. For example,

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"ㄓㄨㄢ" is mapped to "ZHUAN" and "ㄌㄧ" is mapped to "LI". The Pin-

Yin representations can also be organized as a lexical structure tree, as shown

in Figure 2.

4. In this invention a mouse is used as the pointing device on the screen for the

   convenience of illustrations. It is understood that other pointing devices can

   also be used instead of a mouse.

5. In this invention only one button will be used for mouse operations. The

   following five mouse operations will be used. a) press the mouse button with

   the mouse cursor placed on a key. b) touch a key with the mouse cursor, i.e.,

   move the cursor on the screen from outside the key to enter the key top area. c)

   release the mouse button with the mouse cursor placed on a key. d) click the

   mouse button with the mouse cursor placed on a key. e) move the mouse

   cursor. The click operation is the combination of a press operation followed by

   a release operation. The first four mouse operations will be also abbreviated as

   a) press a key; b) touch a key; c) release a key; and d) click a key.

DETAILED DESCRIPTION

The following description of embodiments of this invention refers to the

accompanying drawings. Where appropriate, the same reference numbers in different

drawings refer to the same or similar elements.

A platform and an input method for the Zhu-Yin phonetic system, and a platform

and an input method for the Pin-Yin phonetic system, consistent with the present

invention are described. These platforms and methods allow a user to input Chinese

phrases to be further used either in text generation, or in text editing, or in specifying

queries in text retrieval or other application programs. Figure 3 shows the flow chart

of the general steps of an embodied program of this invention.

A. PLATFORM AND METHOD FOR ZHU-YIN PHONETIC SYSTEM

Platform Components

Figure 4 illustrates a diagram showing the soft keyboard 410 and the phrase

window 420 components of the input platform for the Zhu-Yin phonetic system in

accordance with an embodiment of the invention.

The soft keyboard is the place where a user operates a mouse to send in

sequences of event signals into a computer. A program in the computer translates the

sequences of event signals into sequences of phonetic symbol strings, finds matching

phrases, and displays the phrases in the phrase window. Phrases are displayed on

buttons of the display window for a user to select with a click.

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SOFT KEYBOARD LAYOUT

The Zhu-Yin keyboard contains 37 phonetic symbol keys, from"ㄅ" to"ㄦ", five

tonal keys, three blank keys ☐ for the C, H, and V sets, and several function keys.

The keyboard design is based on the following considerations:

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1. The phonetic symbol keys and tonal keys are grouped into C, H, V, and T

   sections and placed consecutively from top to bottom on the keyboard.

   This arrangement not only helps the key searching process, it also

   facilitates the mouse operations, as to be described in later sections.

2. The 22 C-set keys are gathered into six groups as [ㄅㄆㄇㄈ, ㄉㄊㄋㄌ,ㄍ

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   ㄎㄏ,ㄐㄑㄒ,ㄓㄔㄕㄖ,ㄗㄘㄙ☐]. The six groups are arranged from top

   to bottom and from left to right in the C section area.

3. The 4 H-set keys[ㄧㄨㄩ☐] are arranged in a row and placed between the

   C section and the V section to facilitate mouse touch operations.

4. The 14 V-set keys are gathered into three groups as [ㄚㄛㄜㄝ,ㄞㄟㄠㄡ,

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   ㄢㄣㄤㄥㄦ☐]. The three groups are arranged from left to right in the V

   section area.

5. The 5 T-set keys [˙ˊˇˋ˜] are arranged in a row and placed below the V

   section to facilitate mouse touch operations.

6. The keys within each group of the C, H, V, and T sections are arranged in

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   the standard Zhu-Yin symbol order inside the group. Spaces have been

   reserved between neighboring groups.

The partitions of the keys into sections and groups, the order of groups within each section, and the order of keys within each group provide a user with a simple and logical sense of the locations of the keys. This sense enables a user to find a key on the keyboard at a glance.

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Function keys

The function keys used in this system are described below.

1. ⊡ : The key to indicate that the current keyboard is using Zhu-Yin system. When clicked, the keyboard will be changed to Pin-Yin mode.

10   2. ⊡: This is a simple editing button to erase the phonetic symbol string of the current word.

3. ⊡ : When clicked, the phrase window will be changed to the previous page.

4. ⊡: When clicked, the phrase window will be changed to the next page.

15   **Press-Touch-Release-Touch (PTRT) Mouse Operation**

A Press-Touch-Release-Touch (PTRT) sequence of mouse operations has been designed to allow a user to efficiently select the C, H, and V phonetic components and the tone T component of a Chinese word, all in one continuous mouse movement. A standard PTRT-operation consists of the following mouse operations. 1. Press a

20   consonant key to select the consonant symbol. 2. Move the cursor to touch a transition vowel key to select a transition vowel symbol. 3. Release the mouse on a vowel key to select a vowel symbol. 4. Move the cursor to touch a tone key to select a tonal symbol.

For example, to select phonetic symbols " ㄐ ", "一", and "ㄝ" and tone "1"

12

(Figure 5), a user can perform the following actions of a PTRT-operation. 1. Press the

key " ㄐ " in the keyboard. 2. Move mouse cursor to touch the key " ― " to select. 3.

Move the cursor to the key " ㄮ " and releases the mouse button for its selection. 4.

Move the cursor to touch the tone "1" to select.

5   A user can specify only the leading portion of a phonetic string by releasing the

mouse button on keys in the C section or the H section. For example, if the user

presses the key " ㄐ " , then touches " ― ", and then releases the mouse button, he has

effectively entered the string " ㄐ ― ", which is the leading string of " ㄐ ― ㄮ ".

Some pronunciations may have the C or H components missing. In those cases, an

10   implication rule is useful to fill in blanks. For example, if the user at the beginning of

a PTRT-operation presses the key " ― ", which is a symbol in the H-set, the C

component must be a blank. Similarly, if the user presses the key " ㄥ " at the

beginning of a PTRT-operation, which is a symbol in the V-set, both the C and V

components must be blanks.

15   The grouping and the placement of the phonetic keys on the soft keyboard 410

(Figure 4) has been designed to facilitate the PTRT-operations. The C, H, V and T

sections have been placed from top to bottom on the Keyboard with the H section

lying between C and V sections so that the PTRT-operation can go starting from the C

section, crossing the H section, moving to the V section, then crossing the T section

20   just like drawing an ordinary stroke using a pen. The dimension of the H section is

arranged to be perpendicular to the direction from the C section to the H section to

make it easier for the cursor to touch a transition vowel and while avoiding generating

spurious touch event signals. Similarly, the dimemsion of the T section is arranged to be perpendicular to the direction from the V section to the T section to facilitate the touching of tone keys.

5   **Automatic Partial Zhu-Yin Spelling Separation Protocol**

For an arbitrary sequence of partial Zhu-Yin spellings, a sequence of PTRT-operations on the Zhu-Yin soft keyboard can be found for its generation. Separation marks between the partial spellings can be generated automatically in the process.

10   This special capability of the PTRT-operation design comes from that the entering of every partial spelling is started by a key "press" in a PTRT-operation, and every PTRT-operation contains one and only one key "press". Therefore a "press" event signal indicates that the user intends to start a new partial spelling; it also indicates the end of the previous partial spelling.

15   The above stated special partial spelling separation property of a sequence of PTRT-operations on a Zhu-Yin soft keyboard can be implemented into a protocol for the generation of a sequence of partial spellings from a sequence of mouse event signals. The protocol automatically inserts a separation mark "~" in the generated symbol string when a key "press" event signal is received.

20   Figure 6 uses a non-deterministic state transition diagram to define the operation of the *automatic partial Zhu-Yin spelling separation protocol* of this invention. Mouse event signals will activate the transitions among states. Depending on the current state, the current partial spelling, the event signal, and the key information, a symbol string may or may not be generated, as shown by the [event -> output symbol

25   string] pairs on the branches of the state transitions. For example, [press 坐 -> ~坐]

14

denotes that a press on the key of consonant "ㄓ" generates a separation mark "~"

followed by the symbol "ㄓ". In the diagram, "" denotes an empty string.

It can be checked on Figure 6 that a user can apply the *automatic partial Zhu-Yin spelling separation protocol* to generate arbitrary sequences of legitimate partial Zhu-

5   Yin spellings with the separation marks properly inserted. The following paragraphs

show two examples. In the diagrams of the examples, the generation processes went

through the states of the protocol in Figure 6 with input event signals shown above the

state transition branches and the generated sequence of partial spellings shown below.

The currently translated output symbol string in each step is shown underscored and

10   appended to the total currently generated symbol string.

Generate a sequence of Zhu-Yin full spellings by the protocol

Figure 7 shows an example to generate the sequence of full spellings "~ㄓㄨㄢ 1~

ㄌ一 4" of "專利".

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Generate a sequence of Zhu-Yin partial spellings by the protocol

Figure 8 shows an example to generate the sequence of partial spellings "~ㄓㄨ~

ㄌ一" of "專利".

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B. PLATFORM AND METHOD FOR PIN-YIN PHONETIC SYSTEM

A soft keyboard for the Pin-Yin phonetic system can be designed to allow PTRT-operations similar to that for the Zhu-Yin phonetic system although the lexical

5   structures of the two phonetic systems are different (Figure 1 and Figure 2). In the design the Pin-Yin soft keyboard consists of key panels and function keys. Every key in the key panels is associated with a single symbol or a symbol string. The panels are shown on the screen dynamically according to the sequence of mouse event signals already entered, as described in the following paragraphs.

10   **Phonetic symbol string partition**

To implement the PTRT-operation for the Pin-Yin system, every Pin-Yin spelling symbol string is partitioned into four segments – the initial symbol, the next symbol substring, the remaining symbol substring, and the tonal symbol. They are described below.

15   1. The initial symbol I-set: {A, B, C, D, E, F, G, H, J, K, L, M, N, O, P, Q, R, S, T, W, X, Y, Z }. This is a subset of all alphabet symbols "A" to "Z".

2. The next substring N-set: The set of the symbols that follow a initial symbol in the I-set and the length-two symbol strings that begin with symbol "H" and follows a initial symbol in the I-set in a Pin-Yin spelling (Figure 2).

20   For example, each one of the symbols of {A, E, I, O, U} may follows an initial symbol "B" in the I-set in the Pin-Yin phonetic system. Therefore, {A, E, I, O, U} is the set of the next sub-strings of "B" in N-set.

As an example of the length-two symbol string case, the initial symbol "Z" may be followed by the symbol "H" in some Pin-Yin spellings. Therefore, the

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next substrings of "Z" include {HA, HE, HI, HO, HU} in addition to {A, E, I, O, U} (Figure 2).

3. The remaining string R-set: Given an initial symbol and a next substring, the set of the corresponding remaining substrings is the set of all the remaining portion of valid phonetic symbol strings that follow the given initial symbol and the next substring in Pin-Yin spellings.

For example, the three strings that can follow the initial symbol "J" and the next sub-string "IA" are "NG", "AN", and "AO". "JIA" itself is also a valid string. Therefore, the set of the remaining strings for "J" and "IA" is {NG, AN, AO, □ }, where "□" represents an empty remaining string.

The maximum size of the set of the remaining strings is 9 in the Pin-Yin system.

4. The tonal symbol T-set: As in the Zhu-Yin system, tonal symbols {0 1 2 3 4} is referred as the T-set and can also be represented as { ˙ - ˊ ˇ ˋ }.

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SOFT KEYBOARD LAYOUT

Figure 9 illustrates a diagram showing the initial soft keyboard 910 and the

phrase window 920 platform components for the Pin-Yin phonetic system in

5 accordance with an embodiment of the invention.

The initial soft keyboard 910 consists of the panel of the 26 alphabet keys, from

"A" to "Z", the panel of the five T-set tonal keys, and several function keys. The keys

and panels are arranged as follows.

1. The 26 alphabet keys are gathered into eight groups as [ABCD, EFG, HIJ,

10 KLMN, OPQ, RST, UVW, XYZ].

2. The eight groups are arranged in alphabetical order and placed from left to

right, top to bottom onto the I-set panel with spaces reserved between

neighboring groups.

3. The keys in each group of the I-set are arranged in alphabetical order inside

15 the group.

4. The five T-set keys [--] are arranged in a tone section and placed below the

I-set panel to facilitate mouse touch operations.

The grouping of keys, the order of groups on the panel, and the sequence order of

20 keys within each group provide a user with a simple sense of locations of the keys.

This sense, enables a user to find a key on the panel at a glance.

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Function keys

The function keys used in this system include:

升 : The key to indicate that the current keyboard is using Pin-Yin system.
When clicked, the keyboard will be changed to Zhu-Yin mode.

5   **⬑**: This is a simple editing button to erase the phonetic symbol string of the
current word.

⬆ : When clicked, the phrase window will change to the previous page.

⬇: When clicked, the phrase window will change to the next page.

The panels of the N-set keys and the R-set keys will be shown dynamically in a

10   key-in process, as described below.

Press-Touch-Release-Touch (PTRT) Mouse Operation

A user can also apply the Press-Touch-Release-Touch (PTRT) sequence of mouse

operations on the Pin-Yin keyboard as with the Zhu-Yin system. A standard PTRT-

15   operation consists of the following mouse operations.

1. Press an alphabet key in the initial I-set panel. A panel containing keys of

   the N-set symbols or symbol strings of the selected initial symbol will pop

   up on the screen. For example, if the user pressed on "D", the

   corresponding panel of "D" containing keys {A, E, I, O, U} will pop up on

20   the screen above the I-set panel (Figure 10). In cases where some of the

   next substrings contain symbol "H", two panels will pop up, with one

   containing single symbol keys shown above and another containing keys

of length-two string with leading "H" shown below the I-set panel (Figure 11).

2. Move the cursor to *touch* a key in the next substring N-set panel or panels to select the next substring. A panel containing the keys of the remaining substrings that can follow will pop up. For example, if the user presses on "Z", then move the cursor to touch key "HA" in the N-set panel of "Z", a panel containing the keys of the remaining substrings { □, N, O, I, NG} will pop up (Figure 12). A candidate in the remaining string R-set panel will show the complete phonetic symbol string of the initial symbol, next substring, and the remaining substring together with a label of a representative Chinese word to make recognition easy. In Figure 12, five complete phonetic strings are shown as { 扎 ZHA, 摘 ZHAI, 占 ZHAN, 張 ZHANG, 召 ZHAO}.

3. Move the cursor onto a key in the R-set panel and release the mouse button. For example, in Figure 12, the user moves the cursor onto the key labeled as "張 ZHANG" and releases the mouse button. The alphabet symbol string entered is "ZHANG".

4. Move the cursor to touch a tone key in the tone section to select a tonal symbol. For example, in Figure 12 the cursor is moved to touch tone key "1". The symbol string entered becomes "ZHANG1".

Automatic Partial Pin-Yin Spelling Separation Protocol

Figure 13 uses a non-deterministic state transition diagram to define the operation

of the *automatic partial Pin-Yin spelling separation protocol* of this invention.

Mouse event signals will activate the transitions among states. Depending on the

current state, the current partial spelling, the event signal, and the key information, a

5   symbol string may or may not be generated, as shown by the [event -> output symbol

string] pairs on the branches of the state transitions.

Generate a sequence of full Pin-Yin spellings by the protocol

10   Figure 14 shows an example to generate the full spelling "~ZHUAN1 ~ LI4" of

"專利".

Generate a sequence of partial Pin-Yin spellings by the protocol

Figure 15 shows an example to generate the partial spelling "~ZHU ~ LI" of

15   "專利".